Sandia National Laboratories

Environmental Field Geophysics

Geosynthetic Membrane Monitoring System (GMMS)

Need

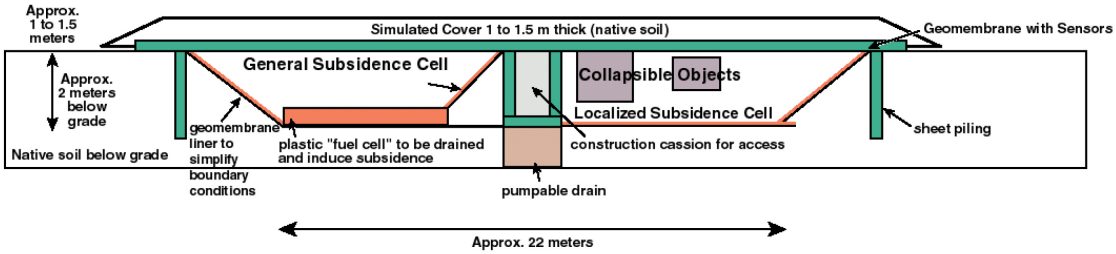
Geosynthetic Membranes, or geomembranes, are commonly used in landfill containment systems, however post-installation status of these membranes is generally unknown. *In situ* monitoring could provide valuable information on the subsidence of the landfill with time. As an alternative to drilling monitoring wells, this project is investigating the use of fiber optic sensors embedded in the geosynthetic membrane for monitoring the effects of water accumulation, subsidence, and age in landfills.

Description

The GMMS uses the concept of "smart" landfill covers and linings that incorporate multiple sensors into the landfill components during construction. We have developed methods to incorporate optical fiber sensor systems within the plastic sheets used as engineered components of the landfill system. Fiber optic lines are embedded into the geosynthetic membranes used for the covers and liners. Monitoring systems can be customized for a particular site; fiber optic technologies can be used to develop sensors to measure subsidence, moisture content, and fluid levels, to detect membrane tears, local subsidence due to collapsed waste containers, to determine slope stability and to monitor road stability.

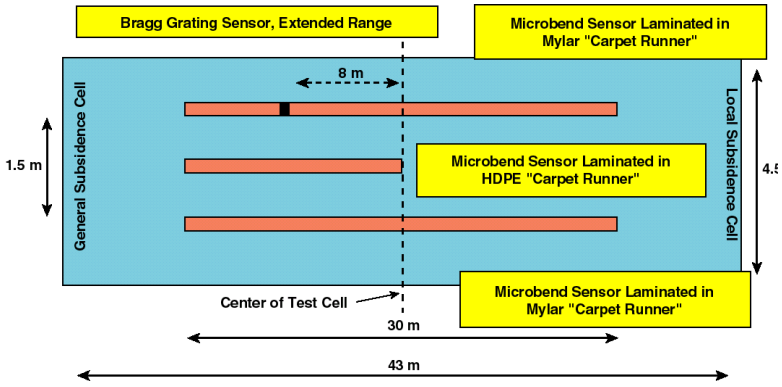
We have investigated two methods for fiber optic incorporation in geosynthetic membranes. The first method is to integrate the optical fibers into the membrane during manufacture. The second method laminates or glues the optical fibers onto the membrane after is is made.

One possible sensor configuration in a GMMS would use optical fibers with microbends five meters apart, or a continuous microbend as a distributed sensor. These sensors are emplaced at regular intervals in the fiberoptic lines. The lines are crimped into microbends (folded like an accordion) in order to detect strains.



Cross-section of simulated landfill used in 1997 field test.

Local subsidence occurring where waste drums or boxes have collapsed can be detected when the microbend "accordion folds" flatten out in response to stretching or tearing in the membrane liner. Similar strain sensors are the basis of fluid level and pore pressure sensors. Chemical sensors are a possible future addition to the GMMS sensor suite.



Layout of fiber optic strain sensors for field test.

Several physical characteristics of optical fibers make them suitable for geomembrane applications. These include small size, lack of susceptibility to stray electrical noise or lightning, and lack of chemical corrosion.

The cost objective of this project is to limit the additional costs incurred by adding sensors to the geomembrane to an additional 20% of the total membrane cost. After the field test is completed, technology transfer to private industry will be pursued.

System Demonstration

In 1996, a pilot scale test was conducted which produced a 15-foot-wide swath of geomembrane; this test demonstrated the viability of the fiber-optic incorporation techniques. A field test is currently being conducted in Albuquerque, New Mexico. Initial results indicate that the fiber optic sensors are detecting and measuring subsidence in the landfill test cell.

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